CS-308-2014 Final Report

Aquaponics

(Automatic Fish Feeding and Monitoring)

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1. Introduction

Aquaponics *(Automatic fish feeding and monitoring)*

Motivation:

Aquaponics is a food production system that combines conventional aquaculture (raising aquatic animals such as snails, fish, crayfish or prawns in tanks) with hydroponics (cultivating plants in water) in a symbiotic environment. Our motivation is to scale the process to a comemrcial and large scale.

Function:

Our projects aims to automate a few of the processes involved in aquaponics, which helps in scaling it to a commercial scale. Feeding the fish according to a schedule and keeping a track of their movements to check if they are alive are automatically done in our project.

We also keep track of the motion of the fish-observe the durations for which the fish doesn't move.

Utility:

Automating the process of monitoring and feeding fishes in an aquarium ensures that no manpower is required in maintaining the aquarium, unless a problem is encountered.

2. Problem Statement

2.1 Product Perspective :

Our project automates the process of monitoring and feeding fishes in an aquarium and ensures that no manpower is required in maintaining the aquarium, unless a problem is encountered.

2.2 User Characteristics :

The user is the owner of the aquariums/greenhouse who wishes to feed and monitor the fishes from a remote location.

2.3 Product Functions :

Initially, our aim is to design a system, with the following functionalities:

- Feeding the fish
    - User creates schedule and specifies the time or issue an instant request to feed the fish using interface provided.
    - At the scheduled time, the mobile phone connected with bot receives a ping to indicate feed time.
    - Through bluetooth/wifi , signal is sent to the bot to feed the fish.
    - Once signal is received , the bot dispenses the food to the fish.
    - The specified amount can be dispensed by controlling the rotational velocity of the motor attached to the dispenser with the help of bot.

- Monitoring/tracking the fish
    - With the help of a webcam, we keep a track of the movements of the fish.
    - If the fish's motion is within a threshold, a message is sent to the user, notifying him

of the lack of motion in the fish.

- User Interface
    - A mobile user interface for the user to interact with the server and the bot
    - User can see the live video surveillance, receive acknowledgements of scheduled feeds and can issue a request to feed the fish.

- Server
    - A server handles the schedule of feeding for multiple users' aquariums.
    - It acts as an intermediate between the users and the corresponding bots.
    - It receives and stores surveillance video from the bots. The users can watch it anytime on their mobile. Also the server uses this footage to check for dead/immobile fishes.

3. Requirements

3.1 Functional Requirements

- Automatically dispensing food in aquarium according to set schedule and dose : The system should be able to dispense the food according to schedule set by the user and the amount of dose specified by the user.
- Monitoring the fishes in aquarium : The system should be able to track the movement of the fish in aquarium and send a message to the user whenever a fish does not move for a long time.
- Web user Interface : In order to set the schedule and the dosage amount, a web interface should be provided to the user.

3.2 Non-Functional Requirements

- Reliability : The system should always be in fully working state so that the fishes get food regularly.
    - Consistent network accessibility : For proper functioning of the food dispenser the system should always have access to internet.
    - Consistent Power Supply : For proper functioning of the food dispenser the bot should always have access to power.
    - Sufficient light availability : For tracking the movement of fish, the camera requires sufficient amount of light.

- Scalability : The system should be developed in such a way that it can be extended easily to multiple users and corresponding aquariums and also other similar environments.

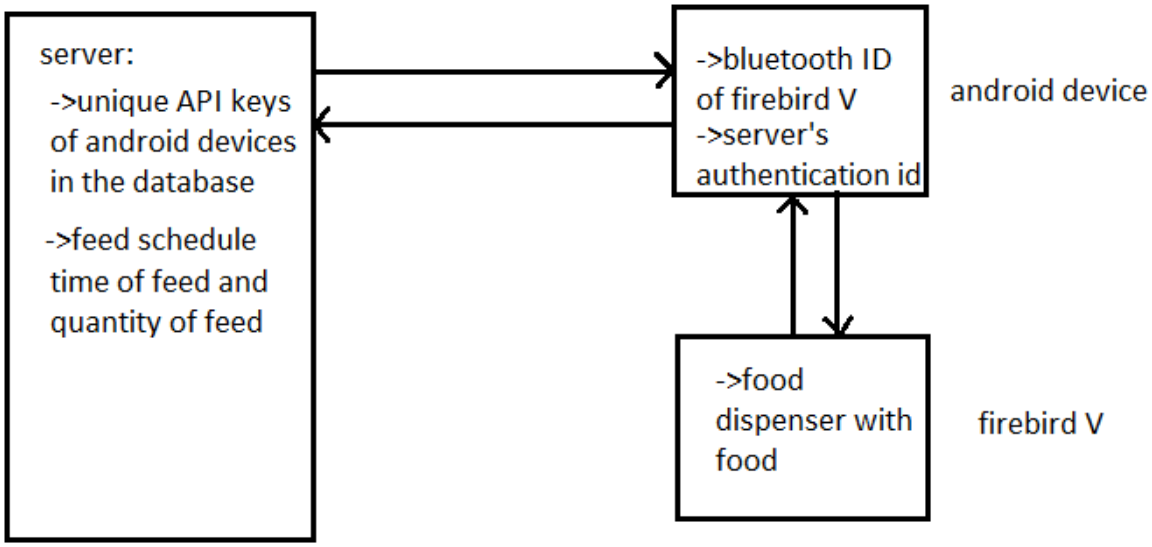
3.3 Hardware Requirements

- Archimedes screw type fish food dispenser
- Firebird V
- Android device to control the Firebird's actions
- Video camera for fish motion tracking and monitoring
- BlueLINK bluetooth module

3.4 Software Requirements

- Keil V
- Android SDK (minimum android 2.2 - target android 4.1 jellybean)
- Web space to host server with mysql database support.
- Python compiler
- OpenCV

4. System Design



The server has two states:

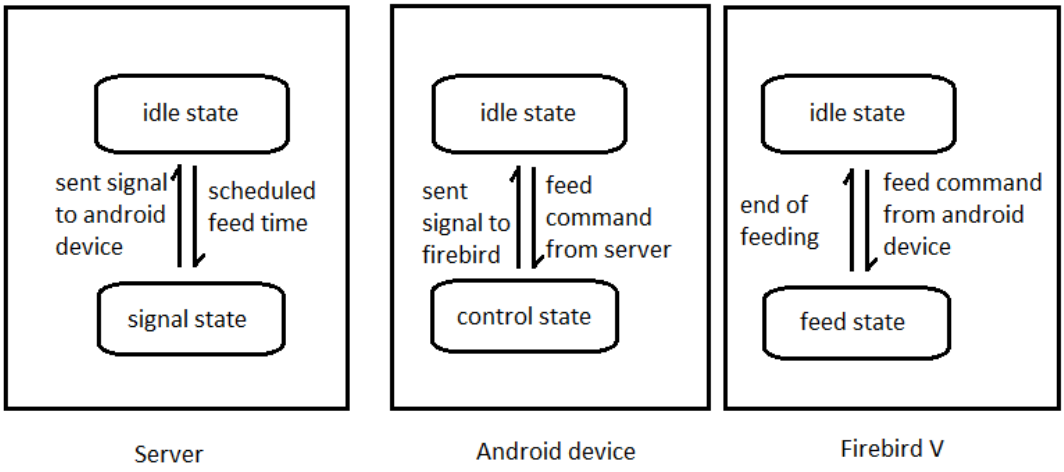
- Idle state: The server keeps track of all pending feed requests stored at the server.
- Signal state: The server sends the appropriate signal to the android device, when the feed request's time has come.
  Sample signal: "high" => Feed signal to dispense a high volume of food.

The android device has two states:

- Idle state: The android device waits for a feed signal from server.
- Control state: Once a feed signal is received, the signal is analyzed to determine the quantity of food to dispence and the number of rotations to be made by the firebird V. Depending on this, an appropriate signal is sent to control the firebird V.

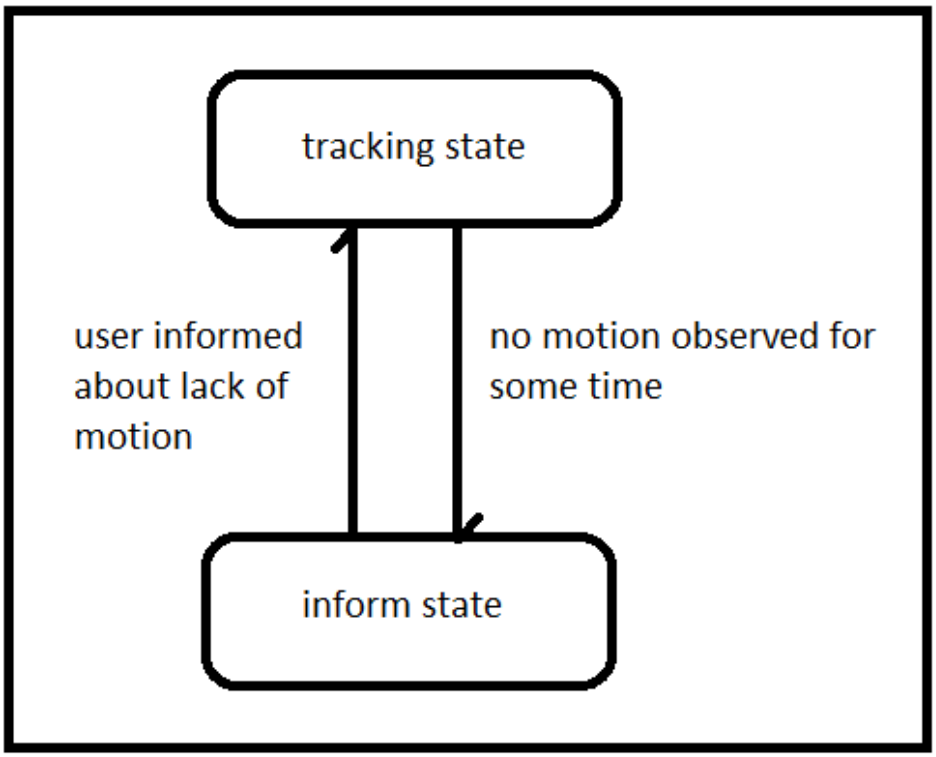
The firebird V has two states:

- Idle state: The firebird V is idle and waits for the control signal from the android device.
- Feed state: Once a control signal is received from the android device, the firebird dispenses the fish feed, by making appropriate number of rotations. Once feeding is done, it returns to the idle state.



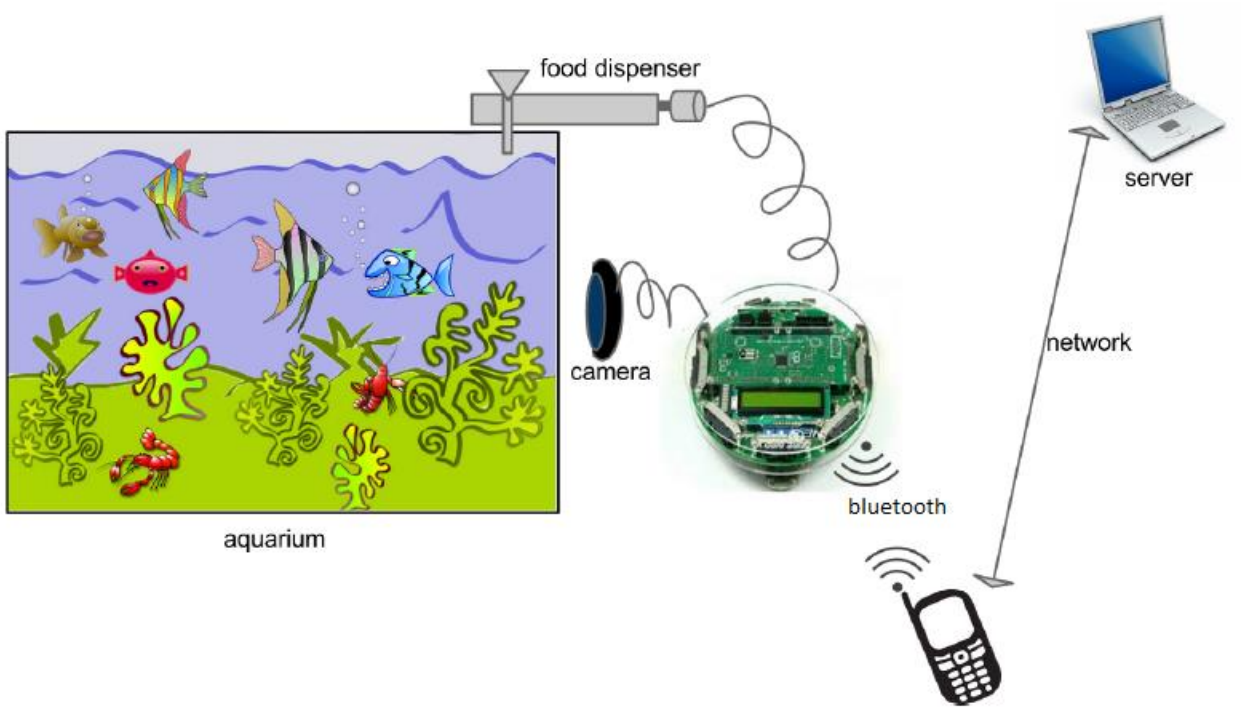
The motion tracking system has two states:

- Tracking state: Using the webcam, the motion of the fish is detected and stored.
- Inform state: When (almost) no motion has been observed in the fish for a long time, the user is informed about this lack of motion in the fish



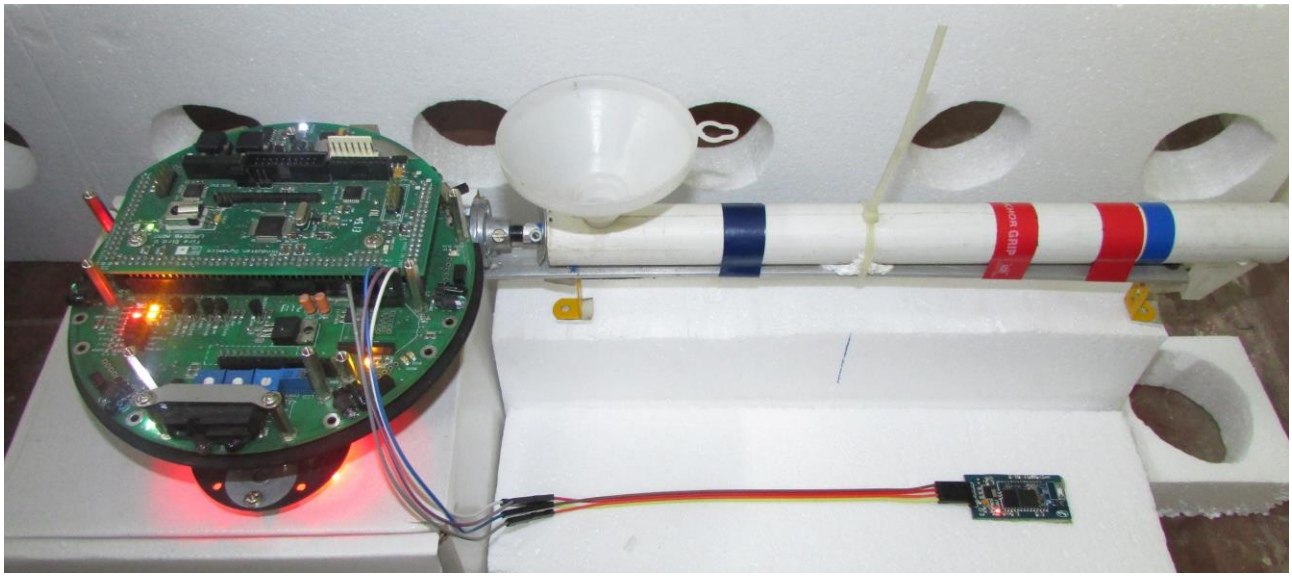
Motion tracking System

5. Working of the System and Test results



Fish feeding:

- After the user registers at the server, he can control the time period of feeding and the dose of food to be dispensed at the server.
- The server keeps track of time, and sends an appropriate message to the android device controlling the firebird V.
- The message contains the information of amount of food to be dispensed.
- The android device then communicates with the Firebird V via bluetooth using the BlueLINK bluetooth module, informing it of the actions it has to perform.
- The Firebird V then proceeds to dispense fish food according to the message it received from the android device.



Motion tracking:

- Using a webcam, we track the motion of the fish.
- Snapshots are taken rapidly, and motion is calculated and recorded.
- If the fish is observed to not move above a certain threshold, an SMS will be sent to the user, notifying him of the lack of motion in the fish.

Testing:

- The system has been tested to dispense fish food within intervals of 30 seconds and 60 seconds, with quantity of fish food dispensed varied as per the user's request.
- This has been done in the presence of wifi, which is required by the android device to receive messages from the server when on localhost.
- The android device successfully received messages from the server and was able to send appropriate messages to the Firebird V which resulted in the correct dispensing of fish food as expected.
- For the motion tracking system, we used a dummy fish controlled using a string.
- The system was able to send an SMS to the user as soon as the lack of motion in the fish exceeded certain time limit(set to 20 seconds for demonstration purposes).

6. Discussion of System

a) What all components of your project worked as per plan?

- Scheduling using a web-server.
- Controlling the actions of a firebird-V over wifi/bluetooth using an android device.
- Tracking/monitoring the motion of a fish and informing user if the fish is inactive.
- Delivering messages to android device via GCM.
- User interface for changing schedule and amount of feed.

b) What we added more than discussed in SRS?

Nothing Significant.

c) Changes made in plan from SRS:

- Earlier the fish tracking algorithm was meant to be for multiple fishes at a time but could

achieve only single fish tracking.

7. Future Work

- One of our components in food dispensing involves the use of a web server to send messages to an android device near a Firebird which signals the bot to dispense fish food into the aquarium. This can be used in other similar environments where messages sent to android devices from a server can be used to control the actions of the Firebird remotely.
- The server can be used to control several Firebirds at a time, and we can expand our project to automate an entire Aquaponics systems.
- We can extend the motion tracking algorithm to track multiple fishes simultaneously.

8. Conclusions

In conclusion, our project has been able to design/develop a way to remotely track/monitor the aquarium, and dispense food into it periodically. It is developed in such a way that it can be easily scaled for multiple environments. Also the same system can be extended to other similar environments where a server needs to control Firebird periodically.

9. References

- Bluetooth communication Android tutorial:
- Android Bluetooth connectivity guidelines: http://developer.android.com/guide/topics/connectivity/bluetooth.html
- Python OpenCV tutorial: http://docs.opencv.org/trunk/doc/py_tutorials/py_tutorials.html
- GCM tutorial for push notifications - http://www.androidhive.info/2012/10/android-push-notifications-using-google-cloud-messaging-gcm-php-and-mysql/
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